Office of Technical Assistance Research Proposal

"Low Salt" Fiber Reactive Dyes

BACKGROUND

The use of fiber reactive dyes in the textile industry requires the addition of a large amount of salt to achieve dye exhaustion, traditionally up to 150 % of the weight of the fabric being dyed[1]. Salt not only facilitates the binding process of reactive dyes to cellulosic fiber, it also prevents the large scale bonding of water molecules to the negatively charged dyes, which produces inert "dead dye". This large amount of salt, when discharged into bodies of water, causes an increase in ecological salinity, sometimes to the point of killing fish and other biological organisms. Effluents with high salt concentrations, when mixed with effluents from other textile production areas, have also been found to have synergistic effects on toxicity. For this reason, the Environmental Protection Agency and individual state environmental agencies have begun to lower the acceptable limits on salinity levels in textile plant effluents.

A considerable amount of research has been conducted in an effort to alleviate the high salt concentration in textile plant effluents, both through modifying the chemical makeup of the dyes and by introducing variations to the dyeing process. For their part, the dye industry has been able to reduce the salt addition requirement for fiber reactive dyes to the range of 50 - 60%, based on the weight of the fabric dyed, for some colors. They have had difficulty, however, reaching this level for all shades.

Other efforts to alleviate the high salt effluent concentration include the following:

- Removing color (either by oxidation or membrane filtration) from effluent and then reusing salt water for next dye bath,
- Using lower liquor-to-goods ratio dying equipment, which lowers amount of salt needed for exhaustion,
- Employing pad-batch dyeing which uses cold reactive dyes and thus requires no salt addition.

The above solutions have been relatively successful for some dye shades, but have not provided a universal solution for all shades: light, dark, dull, and bright. Many textile facilities are still faced with difficulties in lowering their effluent salt concentration.

SCOPE OF PROBLEM

Fiber reactive dyes are used predominantly for dying cellulosic, or cotton, fibers. The popularity of cotton fabric has grown tremendously in recent years. Cotton currently accounts for approximately 64% of the total fiber consumption in the US apparel market. As a result, fiber reactive dyes have become the largest commercial value dye class in the United States[2]. OTA has worked with three facilities in Massachusetts that use fiber reactive dyes requiring the addition of large amounts of salt. The reduction or elimination of the use of salt in the dying process would not only result in a cleaner effluent for these facilities, but would also provide a significant raw materials cost savings. As a result, these companies are interested in using less salt, and thus could potentially serve as industry partners. The Massachusetts Manufacturer's Directory lists

15 facilities under the heading “Textiles – Finishing Cotton”. While it is not certain that all of these facilities dye cotton using fiber reactive dyes or use ones that require the addition of large amounts of salt, the majority (but not all) of facilities that dye cotton use fiber reactive dyes and the vast majority of all fiber reactive dyes require large amounts of salt. Therefore, we believe that there are more facilities in Massachusetts than the three OTA has worked with that would benefit from this project. In summary, this project has the potential to directly benefit Massachusetts' facilities as well as to contribute to the development of more environmentally friendly fiber reactive dyes across the textile industry.

OBJECTIVE

Research on this topic could take several routes. Basic chemical research in the specifics of the binding mechanism could be followed by the design and development of new dye molecule structures that require less (or no) facilitation by disassociated salts. Alternatively, current process techniques could be evaluated and less salt-intensive processes developed. Both of these broad approaches could lead to the development of a dying process that would reduce or eliminate the amount of necessary salt addition.

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[1] Cook, ‘Salt Requirements put Pressure on Wet Processing Plants’. *Textile World*, August 1994 (83-86)

[2] EPA Profile of the Textile Industry